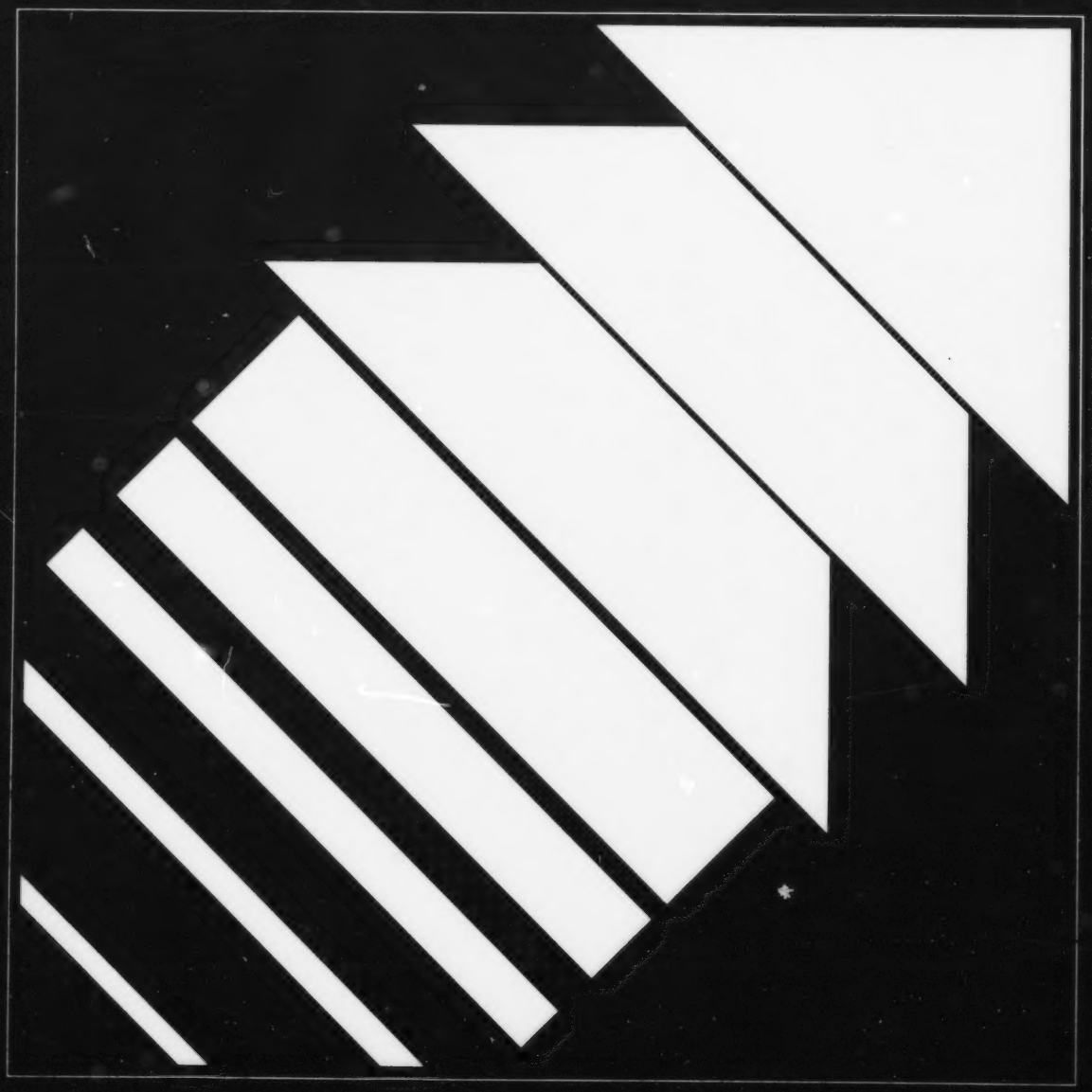
NATIONAL URANIUM TAILINGS PROGRAM



Energy, Mines and Resources Canada
Energie, Mines et Ressources Canada

Canada

THE LONG-TERM SAFETY ASSESSMENT OF URANIUM MILL TAILINGS: NATIONAL URANIUM TAILINGS PROGRAM PLANS FOR 1985/87

NUTP 85-5 (TR)

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April 1985

35 pp

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1. BACKGROUND

The origin, development and status of the National Uranium Tailings Program (NUTP) as of March 1985 were presented in an Interim Report on the Program. As pointed out in that report, the National Technical Planning Group in 1981 recommended a major research program, which they anticipated might take as long as ten years to complete. They recommended that the program be funded at $18 million over an initial period of three years. The results would then be evaluated and a decision made on the quantity, nature and funding for continuing work. The main objective of the program was to provide a scientifically credible information base and a methodology which could be used to predict the long-term effects of uranium mill tailings and, in that way, assist government and industry in developing suitable criteria for the long-term protection of man and his environment.

The NUTP was eventually funded unilaterally by the federal government at approximately $8.5 million and has spent almost $4.5 million during its first 2 1/2 years. There remains approximately $4 million. While a good start has been made towards achieving the overall objective, a great deal of work still needs to be done.

The NUTP staff has had many difficulties to overcome. In the first place, the contracting process has been more time consuming than anticipated, particularly when the need arose to go to two-stage bids in several areas. Secondly, the Program staff can only supervise efficiently between $500,000 and $1 million per year per person depending upon the nature of the work. The use of outside scientific authorities is possible and has been done in some areas but the attention to both scientific detail and project management necessary in such a focussed program, have been hard to find. Thus, the Program has not been able to make extensive use of outside

scientific authorities. The Program has benefited immensely however from a large number of outside people who have helped to evaluate projects, formulate statements of work, evaluate proposals and who have provided expert advice in specific areas.

As a third point, the concurrent pursuit of the major field studies has also stretched resources, such that the research into fundamental understanding has fallen behind. Yet this research is extremely important since it is only the basic understanding which permits predictions of future behaviour to be made with any confidence at all. It is predictions, of course, which are needed for decision.

The resources remaining are sufficient to carry the Program for 18 to 20 months from April 1985 at present rates. The key question then is how to plan the wise use of these resources pending the pursuit of further resources to complete the overall work. The results and recommendations of completed contract work, the recommendations of the Technical Advisory Committee and the advice of the Program Review Board have all been considered in addressing this question.

2. OBJECTIVES

The overall objective of the Program has been restated in more detail to focus attention on what is really required. These objectives were discussed in the Interim Report and are summarized here for ease of reference in the subsequent discussion of planning. These objectives are:

a) Develop the basic understanding of the chemical and physical processes operating in Canadian uranium mill tailings necessary for modelling long-term behaviour. Develop mathematical algorithms and component models for these processes and validate where possible.

b) Develop a system modelling framework to predict long-term effects and assess the cost effectiveness of different options in reducing those effects. This approach should account explicitly for variability in system parameters and uncertainty in future events. Develop the context for using this information in decision-making.

c) Use major field studies to pilot and demonstrate the methodology, calibrate models for those specific applications, and confirm the modelling approach to the extent feasible.

d) Assemble a uranium tailings database and establish it in a long-term home.

3. PLANNING APPROACH

Resources are limited such that the Program is not going to be able to do everything. Therefore, the main focus will be to complete a review of the fundamental science and technology of uranium mill tailings management and long-term behaviour and on advancing the art or science in as many areas as possible. This focuses the bulk of the effort remaining on objectives (priorities) (a) and (b) and will complete what is a development stage of the NUTP, i.e. a stage in which the emphasis is on developing an understanding of the relevant science and technology, along with the methodology for using it to make decisions.

The application of this methodology to real systems is left to, and will form the basis of, a possible second stage of the Program. This second stage focusses on demonstrating the approach through doing actual assessments for the field-study sites along with the fundamental science and technology studies necessary to support those assessments. Thus, the second stage would clearly be a step forward in the direction of implementing what has been learned and developed.

These ideas are the basis for the plan shown in Figure 1. This figure shows the development stage and a tentative demonstration phase. For fiscal years 1985 to 1987 (completion of development phase) the project areas are chosen to:

a) be within resources (funds and manpower) available

b) complete an assessment of the most important relevant science and technology

c) advance the state of knowledge or methodology where feasible, giving priority to those things which clearly require government funding if they are to be done at all.

4. PROGRAM OUTPUT

The product will be a comprehensive summary of relevant science and technology along with a methodology for using it. A series of reports is planned as shown in Figure 2.

The summary report is conceived as being about 30 to 50 pages long and aimed at the ADM or corporate vice-president levels. It will contain some of the key ideas of the science and methodology and will focus on the Program's political and policy environments.

The major subject area reports will:

a) pull together the essence of what has been learned in each area;

b) be a guide to the research reports;

c) identify remaining gaps in necessary knowledge;

d) be aimed at the manager and the individual contributor levels.

Certain topical reports will also be prepared, typical candidate areas being shown in Figure 2. These will pull together the work of many contracts in a related subject area.

Thus, the main results of the Program (i.e. the base of research reports) will appear in digested and summarized form in the four main Program reports. These will be supplemented by the more brief overall summary, the manuals, we presume a report by the Technical Advisory Committee and one or more reports or pamphlets prepared for public consumption.

5. PROJECT PROPOSALS

Specific proposals have now been prepared for each project and these are presented for discussion in Appendices A, B and C. These proposals specify in more detail the objectives of each project and the approximate timing and resources involved. The planned financial commitments are summarized in Tables 1 to 4. Final allocations are yet to be made to each project, but the amounts shown indicate the approximate levels expected.

Looking at Table 1, about $1 million is already committed for 1985/86, being work carried forward from 1984/85. Thus, there is not a lot of flexibility and the Program has had to limit its scope to only those things thought to be of key importance or in particular need of development. An attempt has been made to ensure that all of the important areas have been touched upon at least once to pull together and evaluate what is available. Of course, it has been possible to push ahead in many of these areas, but even so, many important questions will remain. An important task in the work remaining will be to quantify the nature and relative importance of these deficiencies to provide guidance for continuing work.

TABLE 1

NUTP CONTRACTS SUMMARY 1985/87

	($ 000) 85/86	86/87
Modelling - in place	139	0
- planned	388	270
	527	270
Measurements - in place	573	0
- planned	425	370
	998	370
Disposal Technology - in place	353	0
- planned	413	360
	766	360
Miscellaneous Operating	115	100
TOTAL	2,406	1,100
Contracts Budget:	2,403	1,100

TABLE 2

MODELLING CONTRACTS SUMMARY 1985/87

($ 000)

Contract	85/86	86/87
Miscellaneous from 84/85	32	0
System Model-Phase II	125	0
System Model-Phase III	330	0
Risk Assessment II	40	0
Miscellaneous	0	40
Cost Effectiveness	0	90
Documentation	0	140
TOTAL	527	270

TABLE 3

MEASUREMENTS CONTRACTS SUMMARY 1985/87

Contract	($ 000) 85/86	86/87
Miscellaneous 84/85	281	0
Lacnor	292	0
CANUT Database	20	0
Radium Geochemistry	60	80
Bacterial Studies - Bacteria I	40	0
- Bacteria II	25	0
- Bacteria III	0	50
Chemical Oxidation	70	85
Dust Study (analysis)	30	0
Sedimentation V - Rates	50	0
Sedimentation VI - Remobilization	70	0
Non-radioactive Contaminants	60	70
Biosphere Studies	0	70
Direct Radiation	0	15
TOTAL	$ 998	$ 370

TABLE 4

DISPOSAL TECHNOLOGY CONTRACTS SUMMARY 1985/87

Contract	($ 000) 85/86	86/87
Miscellaneous from 84/85	69	0
Gunnar	284	0
Key Lake II	110	0
Natural Materials I	58	0
Natural Materials II	0	110
Dewatering & Consolidation	80	30
Covers	85	0
Stability of Structures	80	0
Sulphide Removal	0	40
Technology Options	0	80
Manual	0	100
TOTAL	766	360

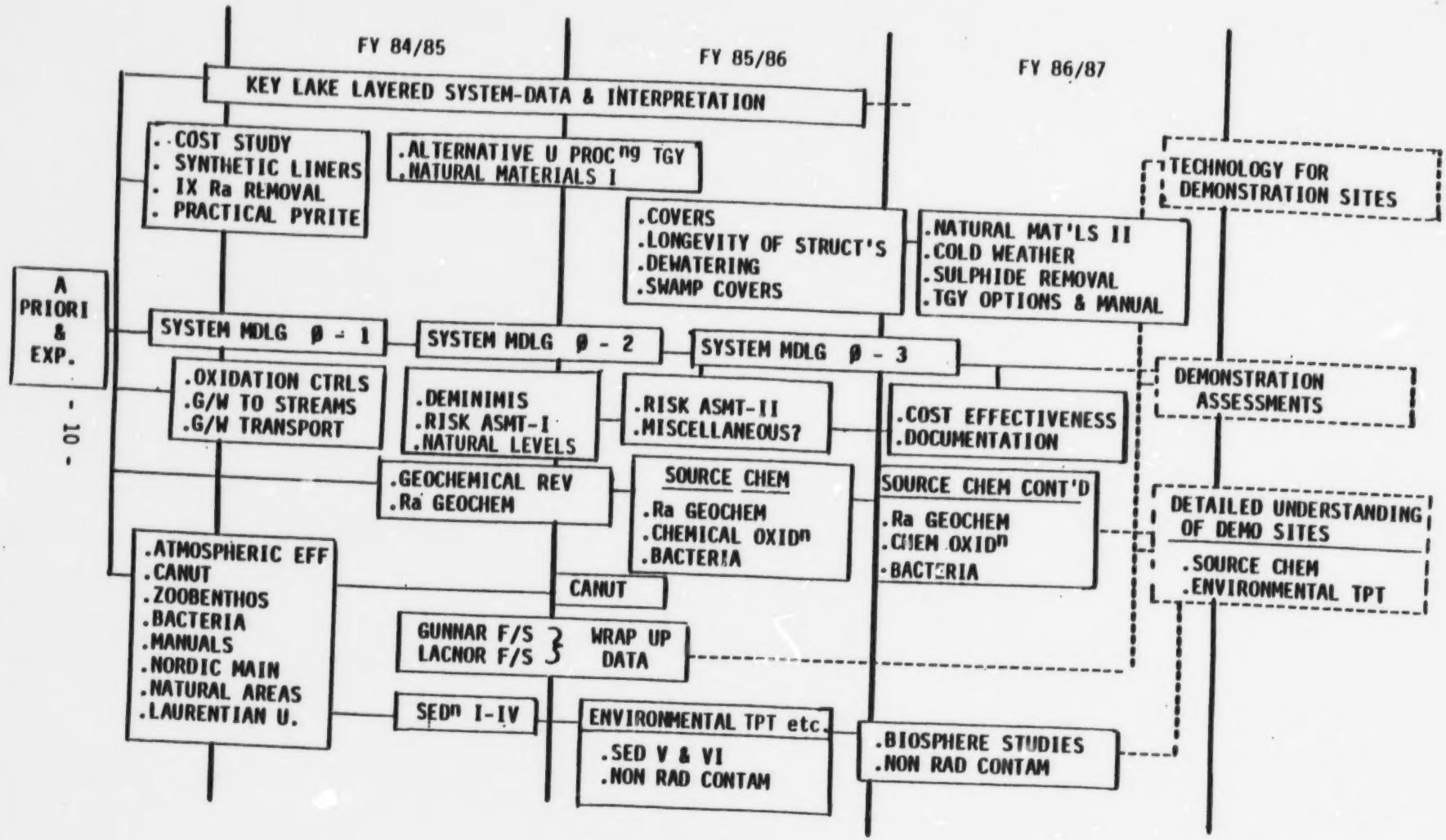

FIGURE 1. NUTP-Program Plan 1983/87

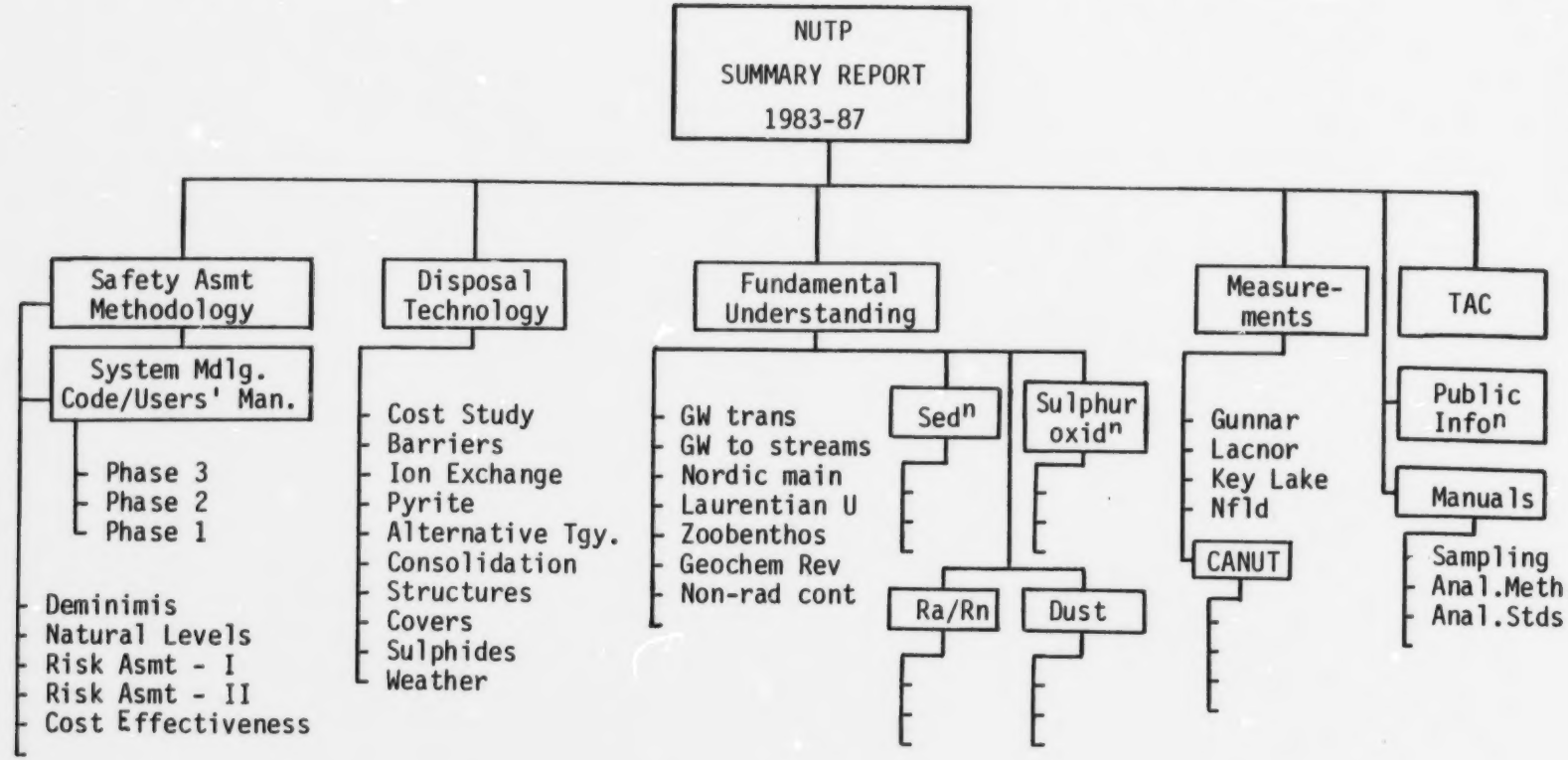

FIGURE 2. Schematic of Proposed Reports

APPENDIX A

MODELLING

NATIONAL URANIUM TAILINGS PROGRAM

MODELLING

PROJECT NO.: UT 050, 060, 070

DATE: March 1984
Revised: March 1985

TITLE: Probabilistic System Assessment of the Long-Term Effects of Generic Uranium Mill Tailings in Canada. (System Model Development)

OBJECTIVE: To develop the methodology for the probabilistic assessment of the long-term effects of Canadian uranium mill tailings. The methodology developed and the data assembled will assist the licensing authority and the industry in selecting appropriate close-out criteria and means of meeting them.

BACKGROUND: Considerable work has been done in Canada on the behaviour of uranium mill tailings and their effects on man and the environment. A method is needed to pull this work together to allow the prediction of long-term effects and the development of regulatory criteria for the acceptable close-out of uranium mine operations. This requires a system model which can include a wide range of interacting phenomena and account for uncertainty in input data and future events. This project will use hypothetical sites representing different generic types of tailings and is the "core" activity in the modelling component.

MAJOR OUTPUTS	83/4	84/5	85/6	86/7	87/8
Preliminary "first cut" analysis demonstrating technique and defining areas requiring work.	*	*			
Initial assessment involving model development, data evaluation and assessment of standard options.		*	*		
Interim assessment including best available data, all options and transient effects.			*	*	
Final documentation				*	*

RESOURCE REQUIREMENTS:

Contracts	90	336	330	140	

NATIONAL URANIUM TAILINGS PROGRAM

MODELLING

PROJECT NO.: UT 061

DATE: March 1984
REVISED: March 1985

TITLE: Cost-Effectiveness Studies

OBJECTIVE: To combine cost information with results from the system assessment models to prepare a cost-effectiveness assessment of several tailings management technologies for different Canadian situations.

BACKGROUND: However desirable absolute standards and objective decision making might be, decision making involving value judgements on behalf of society almost always involves some subjective assessments of relative risks and values. This reality is recognized in the ICRP system of dose limitation and is expressed through the "ALARA" principle which is usually stated as 'ensuring that exposures are kept as low as reasonably achievable, economic and social factors being taken into account'. Judging the extent to which "reasonable achievement" has been reached requires, among other things, information on the cost-effectiveness of various management options. In preparing this information, an attempt will be made to quantify as many "costs" as possible and their uncertainties.

MAJOR OUTPUTS	83/4	84/5	85/6	86/7	87/8
Cost-Effectiveness					
- Interim study				*_____*	

RESOURCE REQUIREMENTS:

Contracts	0			90	

NATIONAL URANIUM TAILINGS PROGRAM

MODELLING

PROJECT NO.: UT251 DATE: March 1985

TITLE: Safety Assessment Studies

OBJECTIVE: The object of these projects will be to continue development of the context for decision-making on the relative safety of disposal options for uranium mill tailings.

BACKGROUND: The de minimis, risk assessment and natural levels studies are looking at different aspects of how you interpret or use calculated numbers in assessing the long-term safety of uranium mill tailings. While these are answering some questions, some aspects remain to be studied and some may need study in more detail. Examples are population effects, multiple sources and multiple scenarios.

MAJOR OUTPUTS	84/5	85/6	86/7
Risk Assessment - II		*——*	
Miscellaneous			*——*
RESOURCE REQUIREMENTS:			
Contracts		40	40

APPENDIX B

MEASUREMENTS AND FUNDAMENTAL UNDERSTANDING

NATIONAL URANIUM TAILINGS PROGRAM

MEASUREMENTS

PROJECT NO.: UT 303 DATE: March 1985

TITLE: Development of the CANUT Database and Preparations for Long-term Ownership (CANUT Database)

OBJECTIVE: The objective for this project has changed from the original long-term plans. We now recognize that CANUT should be placed in its permanent home as soon as possible to enable the long-term owner to participate in its final formulation and to allow sufficient time to transfer it within this stage of the Program.

BACKGROUND: The CANUT database was developed as a prototype system. It was recognized, however, that much work was required to resolve many technical issues such as integration of new data, training, and the need for a more user-friendly system. The original intent had been to place the database with another Federal Government agency at the end of the Program. It became clear that this should be done sooner rather than later to involve the potential new owner in database development. The Technical Advisory Committee suggested that the new owner be the Atomic Energy Control Board. Subsequently, we were approached by Environment Canada to assist with the development of a database, and we suggested they consider assuming responsibility for CANUT. Both Federal agencies are now considering the feasibility of assuming control of CANUT. It is hoped that this can be resolved by spring 1985. The NUTP has agreed to provide both staff and some money to continue database development and to help with the transfer to new ownership.

MAJOR OUTPUTS	83/4	84/5	85/6	86/7	87/8
A fully operational user-friendly database system under the permanent stewardship of a Federal Government agency. Hard copy documentation in the form of an updated user manual and database dictionaries.			*_____*		

RESOURCE REQUIREMENTS:

Contracts 20

NATIONAL URANIUM TAILINGS PROGRAM

MEASUREMENTS

PROJECT NO.: UT 412

DATE: April 1984
REVISED: March 1985

TITLE: Investigation into the Movement and Possible Chemical Interactions of Radium^{226}, Lead^{210} and Thorium^{230} within a Uranium Tailings Matrix. (Radium Geochemistry)

OBJECTIVE: To develop an understanding of the chemical processes involved with the movement of radium^{226}, lead^{210} and thorium^{230} through a uranium tailings matrix. To obtain measurements of the rate of movement and the likely fate of that radium.

BACKGROUND: Most of the radium mined with the uranium ore is distributed throughout the tailings matrix. With the current mill practices the tailings are alkaline and have high sulphate concentrations. Radium appears to be highly retained under these conditions and its movement is very slow. Ultimately, the tailings piles will loose their alkalinity and subsequently lose the sulphate concentration. It is not clear whether this will result in a release of radium and if so, whether the release will be gradual or sudden. As radium is likely to be the most important contributor to dose, this is a vital area for this research Program. These studies will also include work on lead^{210} and thorium^{230}.

MAJOR OUTPUTS	83/4	84/5	85/6	86/7	87/8
A report outlining the chemical nature, chemical stability, migration rate, and predicted migration patterns with varying chemical conditions			*——*	*——*	
RESOURCE REQUIREMENTS:					
Contracts			60	80	

NATIONAL URANIUM TAILINGS PROGRAM

MEASUREMENTS

PROJECT NO.: UT 442

DATE: April 1984

REVISED: March 1985

TITLE: To Develop Profiles of Anaerobic and Aerobic Bacteria in Uranium Tailings Piles and to Investigate the Mechanisms by which these Organisms Affect the Chemical Constituents of the Piles. (Bacteria Studies)

OBJECTIVE: To obtain an understanding of the mechanisms by which bacteria affect pyritic oxidation and sulphur reduction and, thence, radionuclide dissolution in uranium tailings piles. To understand the relationship between anaerobic and aerobic bacteria and to determine the extent to which that relationship affects the dissolution of radionuclides and other heavy metals (such as As, Ni, etc.). To understand the potential for genetic changes in bacteria and their effects.

BACKGROUND: Both sulphur-oxidizing and sulphur reducing bacteria are known to be active within uranium tailings piles. Since bacteria will be long-term inhabitants of these piles, they will likely play an increasingly important role after close-out. It is therefore important to understand what the bacterial actions will be, and under what conditions these mechanisms occur.

In addition we must develop an understanding of the potential effects of genetic and adaptive changes. An in-depth study is currently beyond the resources of this Program. But sufficient information should exist to enable us to obtain a preliminary assessment.

MAJOR OUTPUTS	83/4	84/5	85/6	86/7	87/8
Bacteria I and II:					
Reports delineating the mechanisms and rates with which bacteria alter the chemical nature of various constituents of uranium tailings piles.			*----*	*-----*	
Bacteria III: A report on the potential of genetic and adaptive changes.			*----*		

RESOURCE REQUIREMENTS:

Contracts - Bacteria I			40	
Bacteria II				50
Bacteria III			25	

NATIONAL URANIUM TAILINGS PROGRAM

MEASUREMENTS

PROJECT NO.: UT 432 DATE: March 1985

TITLE: Investigate the Role Played by Chemical Oxidation of Various Elements (primarily pyrite) that will Result in an Increased Mobilisation of Elements of Concern. (Chemical Oxidation)

OBJECTIVE: To develop an understanding of the fundamental processes of long-term oxidation as they occur within a uranium tailings pile.

BACKGROUND: A great deal of work has been done on pyrite oxidation in various matrices. This work now needs to be thoroughly reviewed and, within the objectives of the NUTP, any inconsistencies or omissions should be identified and investigated.

In addition, other oxidation processes that will have a significant environmental impact should also be reviewed and investigated. This is particularly true of the new and complex Saskatchewan ores.

MAJOR OUTPUTS	83/4	84/5	85/6	86/7	87/8
A report giving sufficient understanding to allow the mathematical modelling program to proceed. Any deficiencies to be identified and their impact on the final outcome of the model estimated.			*——*	*——*	

RESOURCE REQUIREMENTS:

Contracts			70	85	

NATIONAL URANIUM TAILINGS PROGRAM

MEASUREMENTS

PROJECT NO.: UT 360, 361

DATE: April 1984
REVISED: March 1985

TITLE: The Potential for Dust Suspension and Saltation Above an Unvegetated Uranium Tailings Pile. (Dust Study)

OBJECTIVE: To estimate the quantity and nature of dust that could be suspended above a uranium tailings pile after close-out. The subsequent objective is to allow the modelling program to predict the dose commitment from this dust source.

BACKGROUND: We received an unsolicited proposal from Atmospheric Environment Research to use University of Toronto facilities to resolve many of the questions associated with this project. A contract with AER is investigating the processes of suspension and saltation at a uranium tailings site surface and will develop an algorithm from the data so measured. However, not all the information we require will be generated in this contract. Therefore, an ancillary contract will be placed to determine particle-size distributions and associated radionuclide distributions.

MAJOR OUTPUTS	83/4	84/5	85/6	86/7	87/8
A report or reports assigning suitable values to suspension, saltation, particle-size distribution and radionuclide distribution under various climatic conditions and through various seasons.		----------*	——*		
RESOURCE REQUIREMENTS:					
Contracts	18	54	30		

NATIONAL URANIUM TAILINGS PROGRAM

MEASUREMENTS

PROJECT NO.: UT 350 - 355

DATE: March 1985

TITLE: Study the Rate of Deposition and Submersion and of Re-transmission of Radionuclides through the Natural Processes of Sedimentation. (Sedimentation Studies)

OBJECTIVE: To study the rate of disappearance of radionuclides within the sediment layer in an aquatic system. To discover the extent to which radionuclides can return to the water column.

BACKGROUND: Available data indicate that organic sedimentary deposits are a major sink for uranium and the radionuclides. Through the process of natural sedimentation, the radionuclides in the surface layer of sediment are gradually buried until they are below the active layer. It is not clear how long this process takes nor is it clear the extent to which the radionuclides can return to the surface waters.

Specific projects to study these phenomena are being written for specific areas. This work is being done in cooperation with several members of Environment Canada staff. Projects by EPS and CCIW are currently underway in Saskatchewan and in Ontario. Great care has been taken to ensure that work done by NUTP neither conflicts with nor overlaps these existing programs. This work has also proceeded with the full knowledge and cooperation of the Provincial Ministries of the Environment.

Four contracts were placed towards the end of 1984. The first, was to do a literature search and review, is now complete. The other three contracts tackled the questions of the role of biological organisms in sedimentation. the role of absorption and desorption, and the role of organics in the sedimentation process. Two further contracts are planned for fiscal year 1985/86.

MAJOR OUTPUTS	85/6	86/7
Sedimentation V: Sedimentation rates and the history potential of cores	*____*	
Sedimentation VI: Remobilization of contaminants from sediments	*____*	

RESOURCE REQUIREMENTS:

Contracts - Sedimentation V	50	
- Sedimentation VI	70	

NATIONAL URANIUM TAILINGS PROGRAM

MEASUREMENTS

PROJECT NO.: UT 456 DATE: March 1985

TITLE: The Role and Chemistry of Non-radionuclide Elements such as Arsenic, Nickel, Cobalt, Manganese , etc. in Uranium Tailings and their Impact on the Environment. (Non-radioactive Contaminants)

OBJECTIVE: To first delineate which are the important non-radionuclides and then to understand their chemistry to such an extent that long-term impacts can be incorporated to the overall modelling program.

BACKGROUND: New and major uranium deposits have been found in Saskatchewan. These new deposits are ores with extremely complex chemistries and contain a wide variety of non-radionuclides. The potential impact of some of these non-radionuclides on the environment is of concern. Under this project we will investigate each element to decide whether it has any hazardous properties. The contractor will then delineate, either by literature review or experimental work, sufficient chemistry to support the modelling program.

MAJOR OUTPUTS	83/4	84/5	85/6	86/7	87/8
A report identifying the elements of concern and containing a discussion of their chemistry			*——*	*——*	

RESOURCE REQUIREMENTS:

Contracts			60	70	

NATIONAL URANIUM TAILINGS PROGRAM

MEASUREMENTS

PROJECT NO.: UT 460

DATE: April 1984
REVISED: March 1985

TITLE: Radionuclide Movement within the Biosphere and the Potential Dose to Man from Pathways through Vegetation and Animals. (Vegetation/Animal (Biosphere) Studies)

OBJECTIVE: To develop an understanding of the mechanisms by which radionuclides move through the living environment (as opposed to the non-living or geological environment). We need to assess the effect of those radionuclides on individuals within the vicinity of a tailings site.

BACKGROUND: Pathways exist for the movement of radionuclides through vegetation and animals to man. These pathways will continue to be important after the cessation of mining and milling. We can only assess the importance of this transfer if we have adequate data. It is possible that sufficient information is available in the literature for our needs.

A considerable amount of work is being done on blueberries, both by our own people at Elliot Lake and by AECL in Pinawa. It is possible that we can use the data from these experiments, in a general way, to cover all vegetation.

MAJOR OUTPUTS	83/4	84/5	85/6	86/7	87/8
One or two reports covering the literature search and an evaluation of the blueberry results and their implications.				*——*	

RESOURCE REQUIREMENTS:

Contracts 65

NATIONAL URANIUM TAILINGS PROGRAM

MEASUREMENTS

PROJECT NO.: UT 550

DATE: April 1984
REVISED: March 1985

TITLE: Evaluation of the Dose Commitment* from Direct Radiation from Uranium Tailings Piles after Close-out. (Direct Radiation)

OBJECTIVE: To develop sufficient data to assess the impact on man and other animals of direct radiation from abandoned uranium tailings piles.

BACKGROUND: Uranium mines contain a large number of radionuclides. During the mining and milling process only 15% of the radioactivity is removed in the form of uranium product and 85% of the original radioactivity is transferred to the tailings piles. Generally speaking these piles have been moved from the underground positions they originally occupied to the surface, where they are able to affect man. If we assume some form of institutional control which will prevent access then this will not be a major component in the final dose commitment. However, we must make an attempt to understand the potential of this parameter. It is expected that we will be able to glean enough information from the literature and that additional measurements, if required, would not be extensive.

MAJOR OUTPUTS	83/4	84/5	85/6	86/7	87/8
Sufficient data allowing modelling of the dose commitment from direct radiation				*____*	

RESOURCE REQUIREMENTS:

Contracts	15

* The terms used by the NUTP will be fully defined so that no confusion exists as to the exact meaning of each term.

APPENDIX C

DISPOSAL TECHNOLOGY

NATIONAL URANIUM TAILINGS PROGRAM

DISPOSAL TECHNOLOGY

PROJECT NO.: UT 730 - 731 DATE: February 1985

TITLE: New Disposal Technology (Key Lake -II)

OBJECTIVE: Provide long-term predictive behaviour of dewatered, bulk-neutralized, complex uranium mill tailings.

BACKGROUND: A preliminary field and laboratory investigation of the tailings deposition at Key Lake is nearing completion. Results to-date have shown that the tailings are behaving chemically as predicted. However, the hydrology of the material differs from predicted because of higher moisture-retaining capacity.

Phase II will measure interaction of water-borne contaminants with engineered barriers of the type used at Key Lake. Continuation of the field monitoring will be required to verify chemistry and obtain additional field data on the effects of frost penetration. Present field observations indicate good potential for residual ice which could significantly upset predicted hydrology.

MAJOR OUTPUTS	85/6	86/7
Key Lake II	*	*

RESOURCE REQUIREMENTS:

Contracts	110

NATIONAL URANIUM TAILINGS PROGRAM

DISPOSAL TECHNOLOGY

PROJECT NO.: UT 640 DATE: February 1985

TITLE: Natural Materials as Long-Term Barriers I and II

OBJECTIVE: Provide long-term predictive capability of select soils to retain water-borne contaminants from uranium tailings.

BACKGROUND: Natural Materials - I, the study of natural soils and amended soils as long-term barriers for water-borne contaminants from uranium tailings, is expected to show deficiencies in experimental and predictive data, particularly for water-saturated high-activity deposits.

A laboratory scale experimental program (Natural Materials - II) is to be undertaken to measure transport of reactive and non-reactive solution through select soils. The most difficult and costly phase of this work will be to identify any transient behaviour or modification of geochemical characteristics of the soils.

MAJOR OUTPUTS	85/6	86/7
Natural Materials I	*_____*	
Natural Materials II		*_____*

RESOURCE REQUIREMENTS:

Contracts	58	110

NATIONAL URANIUM TAILINGS PROGRAM

DISPOSAL TECHNOLOGY

PROJECT NO.: UT 740 DATE: February 1985

TITLE: Dewatering/Consolidation

OBJECTIVE: To develop understanding and provide predictive capacity for dewatering consolidation of uranium tailings.

BACKGROUND: Hydraulically-deposited tailings result in characteristics that depend on the method of deposition, retaining structures, hydraulic and sedimentation behaviour of the slurry, and on the weather. A study will be undertaken to examine historical, current and reasonably applicable methods of deposition of uranium tailings in Canada. Relationships between characteristics of deposited tailings and the method of deposition and the local environment will be developed. Special emphasis will be placed on the physical behaviour (consolidation and strength) and hydraulic behaviour (permeability). Where relevant information is absent, some laboratory testing will be done. The technology of operational dewatering will be included in the study.

MAJOR OUTPUTS	85/6	86/7	87/8
Dewatering & Consolidation Studies	*_____*	*_____*	
RESOURCE REQUIREMENTS:			
Contracts	80	30	

NATIONAL URANIUM TAILINGS PROGRAM

DISPOSAL TECHNOLOGY

PROJECT NO.: UT 690 DATE: February 1985

TITLE: Covers for Uranium Tailings

OBJECTIVE: To describe candidate materials for covers for uranium tailings. Investigate long- and short-term stability and capacity to retain radon and to reduce air and water infiltration.

BACKGROUND: Although the need for the placement of a cover on a tailings deposit is unproven and may vary with the site, it appears that the prevention of surface erosion and the infiltration of water (and oxygen for sulphide-containing tailings) is beneficial.

Two "generic" cases will be studied in detail - one Elliot Lake, one Northern Saskatchewan. The study will be sequential, first reviewing Canadian and international practice, basic characteristics of uncovered sites, the engineering of several types of covers (costs, uncertainty) short- and long-term effectiveness, and then applying this information to the two typical sites.

MAJOR OUTPUTS	85/6	86/7
Covers Assessment	*	*

RESOURCE REQUIREMENTS:

Contracts	85

NATIONAL URANIUM TAILINGS PROGRAM

DISPOSAL TECHNOLOGY

PROJECT NO.: UT 710 DATE: February 1985

TITLE: Long-Term Stability of Control Structures

OBJECTIVE: To determine long-term stability of existing structures and to present conceptual designs for stable dams for uranium mining areas in Canada.

BACKGROUND: To define long-term control of uranium mine/mill wastes, the stability of structures controlling the release of contaminants needs to be predicted. Long-term stability implies maximum utilization of natural structures, and the use of engineered structures that degrade slowly, or improve in stability and will be unlikely to fail catastrophically. The long-term stability of some existing structures will be examined. This examination may include field observations. Conceptual designs with accompanying economic analyses will be developed for structure options for the two major uranium mining areas of Canada.

MAJOR OUTPUTS	85/6	86/7
Stability of Structures	*_____*	

RESOURCE REQUIREMENTS:

Contracts	80

NATIONAL URANIUM TAILINGS PROGRAM

DISPOSAL TECHNOLOGY

PROJECT NO.: UT 750 DATE: February 1985

TITLE: Sulphide Removal

OBJECTIVE: To determine need, methods, costs and effectiveness of sulphide removal from "active" layer of Elliot Lake tailings.

BACKGROUND: Studies have demonstrated that the upper unsaturated layer is the major source of acid generation and radionuclide mobility in Elliot Lake tailings.

A major and significant close-out option for these tailings is the removal of sulphides from the top or final layer. Previous work completed by NUTP will be used as a starting point, and consulting with the operating companies and the regulatory authorities, a study will be conducted that considers the site-specific characteristics of all the Elliot Lake sites.

MAJOR OUTPUTS	85/6	86/7
Sulphide Removal Study		*——*

RESOURCE REQUIREMENTS:

Contracts	40

NATIONAL URANIUM TAILINGS PROGRAM

DISPOSAL TECHNOLOGY

PROJECT NO.: UT 800 DATE: February 1985

TITLE: Disposal Technology for the Long-Term

OBJECTIVE: To identify and quantify the characteristics of various disposal technologies for U tailings in Canada.

BACKGROUND: A study will be completed on the assessment of technology options that are applicable to the two major uranium producing areas in Canada. Special emphasis will be put on the long-term implications of various close-out configurations i.e. coned, sloped, concave or flat. The scope of this study will depend on the results of the covers and dewatering/consolidation studies.

The final element of the Disposal Technology component of the NUTP will be the preparation of a Uranium Tailings Disposal Manual. The emphasis of this manual will be on the application of cost effective technology that will minimize long-term care and impact. Major input for this manual will come from the Modelling and Measurements components. The manual will discuss site selection for typical locations. The level of effort for this project will depend on financial and manpower resources.

MAJOR OUTPUTS	85/6	86/7	87/8
Major assessment of technology options available for Canadian tailings		*_____*	
Preparation of a Tailings Disposal Technology summary report or Manual		*_____*	

RESOURCE REQUIREMENTS:

Contracts -	Technology Options Assessment	80
-	Disposal Technology Report/Manual	100